

Agricultural Practices' Impact on Achieving the Sustainable Development Goal: Eliminating World Hunger

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Abstract

The growth of populations faced with chronic hunger requires the implementation of effective studies and measures to mitigate this problem. The agricultural sector plays a crucial role in achieving this goal. The purpose of this article is to empirically study the impact of agricultural practices on the hunger crisis, with a focus on the European context. The research methodology is based on an analytical design that correlates a statistical analysis of the implementation of organic farming agricultural practices in EU countries between 2010–2020 and how this could affect the alleviation of hunger in those regions. The indicators of labour productivity and organic land are calculated to identify trends in the sustainability of agriculture in the EU between 2015 and 2024. The results demonstrate the differentiation between EU countries by the structure of implementation of different farming methods, with a predominance of conventional methods of soil cultivation. The most common methods are conservation tillage and those with minimal mechanical intervention. The volume of organic farming in the Member States declined between 2010 and 2020. The EU Agricultural Real Income Index, with an upward trend in 2016–2024, indicates the potential of relevant activities to achieve the Sustainable Development Goal of ending hunger. The growth of agricultural labour productivity was driven by mechanization and a reduction in employment. This indicates an increase in the level of sustainability of agricultural practices. The increase in the productivity of organic land in the EU was due to an increase in the demand and thus volume of organic production. Therefore, in general, there are positive changes in achieving the goal of overcoming hunger due to the growth of the agricultural sector income, its overall productivity and the productivity of organic farming land. These factors will serve as the basis for the sustainability of the industry, which could in turn support the mitigation of hunger.

Keywords

Food security; Food market; Agricultural innovation; Sustainable development; Overcoming hunger; Organic farming; Tilling methods

Introduction

Solving the problem of eliminating hunger on a global scale goes beyond the task of ensuring food security by increasing agricultural productivity (Galabada, 2022). Modern innovative agricultural practices are one of the factors in achieving this multidimensional goal by promoting sustainable agriculture (Arora and Mishra, 2022). Increased attention to agricultural practices is also associated with the greatest environmental impact of these activities (Sporchia *et al.*, 2024).

To eliminate hunger, the Sustainable Development Goals by 2020 envisage an increase in agricultural productivity and increased income for small and family-owned farms by ensuring equal and secure access to land, diversified resources, financial markets, and increased opportunities for knowledge sharing and financial support services. Increasing agricultural productivity should be ensured through the introduction of sustainable production methods, strengthening the adaptive capacity of agricultural enterprises to climate change, drought, and gradual improvement of water and land resources. Sustainable agricultural practices help to achieve one of the Sustainable Development Goals, “zero hunger”, as well as maintaining diversity in food production.

Sustainable farming methods, such as organic farming, are only gaining momentum, despite a lack of government support and the need for significant investment (Sporchia *et al.*, 2024). Sustainable agricultural practices that can eliminate and reduce the negative impacts of conventional farming methods, and restore biodiversity and soil (Allahyari and Poursaeed, 2020). The latest agricultural practices also include methods for assessing and collecting data on the condition of land, innovative ways of cultivation, export-oriented practices, and technologies for preventing waste and losses etc.

The Zero Hunger Sustainable Development Goal (SDG2) includes ensuring access to food for all segments of the population, meeting all nutritional needs, doubling agricultural productivity and incomes of smallholder food producers, creating sustainable food production systems, introducing new farming methods, and ensuring plant and animal diversity. In particular, new methods of farming will not only increase productivity in the agricultural sector but also contribute to the preservation of ecosystems and strengthen the ability to adapt to climate change, droughts, and floods. These challenges are closely related to sustainable agricultural practices, which are crucial for environmentally friendly, efficient, and economically viable food production (Hiywotu, 2025).

Sustainable agriculture encompasses a range of practices, policies, and technologies that contribute to this goal. Focusing on the importance of sustainable agriculture for achieving “zero hunger,” researchers emphasize the need for multidimensional strategies that encompass environmental stewardship, social equity, and the economic viability of agricultural systems (Cheo and Tapiwa, 2021). Today, the potential of new technologies such as precision agriculture, agroforestry, and digital platforms to revolutionize food production while minimizing environmental impact is being widely explored. An in-depth analysis of best practices can encourage collaborative efforts and informed decision-making to build resilient and sustainable food systems that can effectively address the global problem of hunger and malnutrition.

This paper aims to empirically study the impact of agricultural practices in the goal of exploring how it could contribute to ending hunger. The focus is on the structure of agricultural practices, organic farming and the productivity of organic farmland in the EU during different periods (2016, 2020, 2022–2024) to determine the dynamics of sustainability of agricultural practices as a prerequisite to mitigate hunger.

Literature Review

The literature highlights the impact of a diverse set of factors that affect the achievement of the Sustainable Development Goal of ending hunger. A set of managerial and technological agricultural practices is aimed at increasing the productivity of the agricultural sector and improving food security, and as a result, reducing hunger (Allahyari and Sadeghzadeh, 2020). According to empirical studies, the level of food stability on a global scale is increasing due to the growth of grain reserves, grain yields, and a decrease in the average amount of labour investment in agricultural land (Chen, Shuai and Wu, 2023; Warr, 2014). There is a strong correlation between increased food supply and reduced hunger (Warr, 2014). The prevalence of hunger is also reduced by increasing income levels and the affordability of food (Ghosh and Sahu, 2023). At the same time, the decline in cultivated areas and employment in the industry requires farmers to find innovative methods of farming (Chen, Shuai and Wu, 2023). Modern conventional farming methods are unsustainable in the long run, so it is crucial to introduce alternative systems of cultivation and production (Batra, Kumar and Soti, 2024). Organic farming is recognized as one of these alternatives, based on agroecological principles, promoting sustainable development and biodiversity (Batra, Kumar and Soti, 2024). Organic farming encompasses the entire farming system, ecological methods of cultivation and production. This means implementing a holistic approach to farming, covering all production stages and processes. Cultivation methods are based on the use of organic fertilizers, mechanical tillage, crop balancing, and plant biological protection. This results in long-term sustainable productivity of the agricultural sector. Agrotechnological innovations (big data technologies, Internet of Things technologies, artificial intelligence) are used to increase productivity in agriculture, optimize resource use and reduce waste, which is usually combined by the term AgriTech. Given that traditional conventional methods of farming and management are not sustainable, they cannot contribute to the goals of increasing food security and efficient use of resources (Lakshminarasimha, 2025). Alternatively, the use of data and artificial intelligence makes it possible to predict yields, optimize irrigation, and prevent plant disease outbreaks. Agricultural robotics reduces farmers' need for manual labour, thus solving the problem of labour shortages in the industry and rising costs. Vertical farming technologies make it possible to create high-yielding indoor farms without pesticides while still producing high-yielding crops. In general, the agricultural sector is automating production quite rapidly, which leads to an increase in demand for skilled workers (Petrović *et al.*, 2024). The integration of artificial intelligence and machine learning technologies into agricultural machinery significantly improves precision farming, increasing yields by 15-20%, reducing the required investment by 25-30%, and improving efficiency by 20-25% (Padhiary *et al.*, 2024). According to Sanyaolu and Sadowski (2024), the costs of plant protection and fertiliser use have been reduced by 15-20% without compromising productivity in Poland, Germany, Romania, and France. Such results are associated with improved crop accuracy, crop monitoring, and precise

pesticide application (Padhiary *et al.*, 2024). Additional benefits of hardware and software technologies include increased operational accuracy and environmental sustainability (Jin and Han, 2024). According to a literature review, the Czech Republic and Germany are leaders in the use of precision farming technologies in Central Europe as a way to increase the quantity and quality of products by controlling production processes based on a large amount of data (Petrović *et al.*, 2024). The main obstacles to the introduction of precision farming technologies in European countries are high investment costs, lack of knowledge, and farmers' lack of confidence in different types of technologies (Sanyaolu and Sadowski, 2024). According to the review of legislation on digital agriculture, national legal frameworks are more important for cooperation between agricultural technology startups and farmers. Existing legislation does not regulate digital agriculture and, consequently, precision agriculture. Therefore, national policy in this area should take this factor into account to stimulate sustainable agricultural production methods (Ibrahim and Truby, 2023). The most recent research on digital agriculture suggests that hunger in Africa could be overcome through innovation for 282 million people by 2030 (Ecorn Agency, 2025).

Methodology

This study uses an analytical design, based on statistical analysis, to assess the state of implementation of agricultural practices in EU countries between 2010 and 2020. The Eurostat database was used to compare the dynamics and volumes of organic farming in different EU members based on data availability in different countries. The selection of countries for the comparative analysis of the Member States was made taking into account the availability of data on the state of organic farming and agricultural practices. Based on the data for 2016, a comparative study was conducted on agricultural practices in terms of land area structure and use. Through this analysis, the state of application of various methods of soil cultivation was determined: cultivation without mechanical processing, direct seeding methods, traditional farming methods, conservation tillage methods with minimal intervention and zero tillage.

To identify changes in resource efficiency in the EU agricultural sector, the dynamics of the industry's real income index in 2016-2024 (as a ratio of all income to annual labour units) were estimated. The calculation of labour productivity in the EU agriculture sector between 2015 and 2024, expressed as the volume of agricultural production relative to the annual number of labourers in the sector, was carried out to identify the general trend of increasing the sustainability of the industry. To understand the state of achievement of the Sustainable Development Goal to eliminate hunger through the activities of the agricultural sector, the productivity of organic farming land in the EU for 2016–2023 was calculated as a key factor. The indicator is estimated as the ratio of arable organic land to organic production (hectares/ton). All statistical data were selected using the Eurostat database.

Labour productivity = Volume of agricultural production / Annual number of labourers
or

Labour productivity = Output of the agricultural 'industry' (Production value at basic price) / Agricultural labour input statistics: absolute figures (billion euro /1000 AWU, annual work units) (1)

Productivity of organic farming land = Arable organic land / Organic crop production, (hectares/ton) (2)

Estimates of achievement of the Sustainable Development Goals as of 2025 in the EU countries were compared with each other (SDG 1, SDG 2, SDG 10) to identify challenges to overcome poverty, reduce inequality, and achieve zero hunger (Lafortune and Grayson, 2025).

The study is limited by the lack of quantitative data on the official Eurostat website on agricultural practices in EU countries since 2020. Data on the dynamics of organic farming is available only for 2010, 2013, 2016, and 2020. This may not fully reflect the current situation regarding the state of agricultural practices in the EU. To address this gap, the European Commission's 2024 reports assessing the state of agricultural practices and soils in the EU were used (European Commission, 2024), as well as additional data on the volume of organic farming in the EU in 2022 (Benefert, 2022; European Environmental Agency, 2025; Forschungsinstitut für biologischen Landbau, 2025). Secondary data and surveys on the structure of farming in individual EU countries further complement this gap (Central Statistics Office, 2025a; DeStatis, 2025; Instituto Nacional de Estadística, 2023). This article summarizes the results of expert research on the state of organic farming in the EU, agricultural technologies, innovations, sustainable approaches to achieving the goal of overcoming hunger, identifying future trends and challenges in the agricultural sector.

Results and Discussion

It was observed that in twenty EU countries, there is an upward trend in organic farming in terms of the amount of agricultural land used in 2010–2020 (Figure 1). Among the EU countries, Greece, Italy, Romania, France, Ireland, and Germany showed the largest reduction. Simultaneously, Iceland, Hungary, Lithuania, Spain, and Bulgaria saw an increase in organic farming in 2010–2020 (Eurostat, 2025a). Countries in Eastern and Southern Europe are showing growth due to EU funding, lower production costs, and a simplified system of doing business for small farms. Instead, local barriers to growth in Italy, France, and Germany are generally associated with rising costs of certification, labour, seeds, and low prices for organic products. Institutional constraints are related to insufficient support for farming, including subsidies to reimburse the costs of sustainable farming practices. In 2022, about 17 million hectares of land were cultivated organically, which is 10.5% of the total agricultural land in use (Benefert, 2022). Additionally, since 2014, the share of organic land in the EU has been growing annually, but there are differences in the implementation of organic farming by country (0.6% in Malta, 25.7% in Austria) (Benefert, 2022). According to the Institute for Organic Farming Research, in 2023, 17.7 million hectares or 10.9% of the agricultural area was organic, with the largest area in Spain, France and Italy (Forschungsinstitut für biologischen Landbau, 2025). According to the European Green Deal “Farm to Fork”, it is planned to reach a target of at least 25% of organic farming by 2030 (European Environmental Agency, 2025).

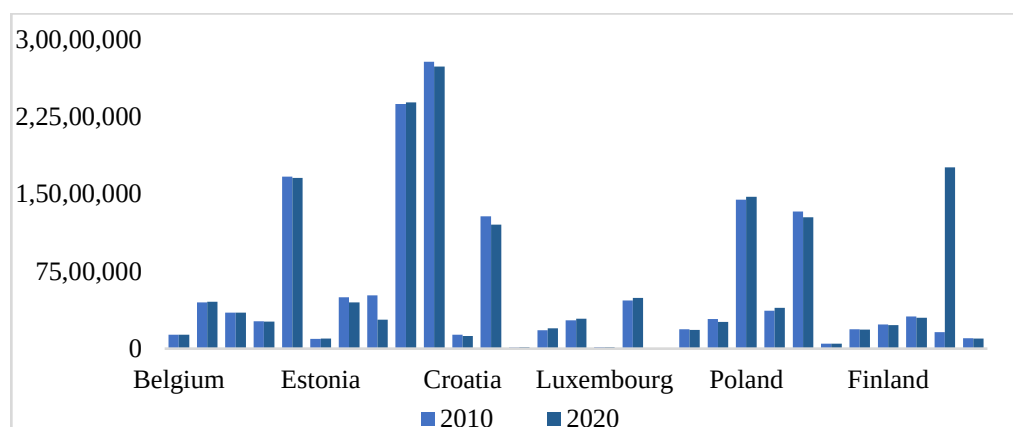


Figure 1: Organic farming in different EU-27 member states in 2010, 2020 (tons)
[Source: Eurostat (2025a)]

There were significant differences in the structure of agricultural practices in EU countries in terms of tillage methods and their prevalence in 2016. In Bulgaria, cultivation methods without mechanical tillage, direct seeding methods (55.2%), or conservation tillage with minimal intervention (41.2%) prevailed. In Hungary and Lithuania, conventional tillage dominates (85.2% and 82.0%, respectively), while conservation tillage is much less common (9.3% and 9.5%, respectively). In Spain, conventional farming also prevails (73.3%), while conservation tillage methods occupy a smaller share (17.6%) (Table 1). According to a survey of the structure of farming in Spain in 2023, traditional methods of soil cultivation remained dominant with a share of 64.3%, while conservation farming methods accounted for 20.6%. In addition, 120.3 thousand or 15.3% of Spanish farms owned robotic equipment in 2023, such as robotic plant protection, soil analysis, precision crop monitoring, and others (Instituto Nacional de Estadística, 2023).

Table 1: Structure of agricultural practices in the EU countries in 2016 (by arable land)

Country	Arable land without mechanical tillage, the direct sowing method	Conventional tillage	The economical way of cultivation	Complete rejection of machining
Belgium	0.71	78.86	10.76	9.67
Bulgaria	3.44	55.20	41.21	0.15
Czechia	2.58	64.84	31.24	1.35
Denmark	0.02	87.93	10.70	1.35
Germany	5.83	53.45	39.93	0.80
Estonia	18.97	43.67	26.59	10.76
Greece	4.63	81.75	13.27	0.34
Spain	2.65	73.28	17.62	6.45
France	14.16	47.99	32.59	5.26
Croatia	4.85	89.57	5.03	0.55

<i>Country</i>	<i>Arable land without mechanical tillage, the direct sowing method</i>	<i>Conventional tillage</i>	<i>The economical way of cultivation</i>	<i>Complete rejection of machining</i>
Italy	12.70	80.37	3.69	3.24
Cyprus	2.48	41.29	52.43	3.79
Latvia	27.92	65.76	5.32	1.00
Lithuania	7.39	81.95	9.46	1.21
Luxembourg	17.23	54.68	25.77	2.32
Hungary	4.46	85.21	9.34	0.99
Malta	1.65	98.35	0.00	0.00
Netherlands	26.40	61.60	11.24	0.76
Austria	14.37	54.49	29>40	1.73
Poland	1.49	93.67	2.75	2.10
Portugal	28.66	33.23	36.66	1.46
Romania	12.18	75.59	2.78	9.45
Slovakia	7.59	70.50	16.69	5.22

Source: Eurostat (2025b)

Countries that have experienced a decline in organic farming have a similar structure of agricultural practices. France and Germany are similar in terms of the shared use of conventional and conservation tillage practices, resulting in 53.5%, 48.0%, 40% and 32.6%, respectively, during 2016. According to the Federal Statistical Office of Germany, in 2022-2023, the following land cultivation indicators were recorded: conventional cultivation of 4.63 million hectares (39%), conservation cultivation of 5.7 million hectares (49%), and direct sowing without tillage of 150.6 thousand hectares (less than 1%). In Greece, Romania and Italy, the situation is similar, where traditional farming methods saw higher use (81.8%, 75.6% and 80.4%, respectively). Instead, Romania and Italy have a higher share of soils cultivated without mechanical tillage methods, direct sowing methods (12.2% and 12.7%, respectively). While in Greece, the use of conservation tillage methods is most common (13.4%).

In Estonia, various farming methods are combined, with the predominance of traditional methods (43.67%), while others are used to a lesser extent (no-till, direct sowing 18.97%, conservation technologies 26.59%, zero tillage 10.76%). At the same time, the volume of organic farming increased by 3.7% from 2010-2020. Austria, the Netherlands, Portugal, and Luxembourg have a diversified structure of agricultural practices. Along with traditional practices, direct seeding without mechanical tillage or conservation ploughing methods is also widespread. In contrast, in Denmark, Croatia, Malta, and Poland, traditional agricultural practices dominate with a share of more than 85% to 90%. In Ireland, in 2023, about 449.9 thousand hectares of land were cultivated using traditional tillage methods (37%), 125.1 thousand hectares (10%) were cultivated using low tillage methods, and 640.7 (53%) were not cultivated (Central Statistics Office, 2025a). In 2023, 6.3 thousand or 4.7% of Irish farms reported having at least one source

of renewable energy in their production, among which the most common were photovoltaic solar panels, with a total of 2.8 thousand units, or thermal solar panels, with a total of 1.9 thousand units (Central Statistics Office, 2025b).

According to a report by the European Commission, approximately 60-70% of soils in the EU are unhealthy due to weak regulations in the industry and insufficiently effective practices of their use, which worsens their condition (European Commission, 2024). These factors have led to a decline in soil productivity as a result of environmentally unsustainable practices. The European Commission considers integrated pest management, organic farming, and conservation agriculture to be the main management methods to address these problems. Each of these practices has several advantages (European Commission, 2024). Additional negative factors affecting soil conditions are the problem of drought due to global warming, water shortages, which lead to soil moisture problems and reduced yields. The limited data on water shortages in the agricultural sector requires the introduction of innovative methods of data collection. However, in general, all of these factors undoubtedly affect the productivity of organic farming and, accordingly, its ability to support the goal of ending hunger (European Commission, 2024).

In the EU, there is also a problem of insufficiently effective resource management, the improvement of which can reduce the use of nitrogen, phosphorus, and potassium fertilizers in agricultural production, while maintaining the potential for soil productivity in the short and long term. The European Commission predicts an increase in the quality of resource management, which will help reduce the use of nitrogen and phosphorus fertilizers (European Commission, 2024).

An additional factor in the more efficient use of inputs in the EU agricultural sector may be the mechanization of operations, such as contributing to fuel savings, improved crop protection, and better use of fertilizers (European Commission, 2024). At the same time, the introduction of agricultural technologies requires a systematic approach and significant investments due to their digitalization and automation.

The main agro-technological innovations used by companies are: artificial intelligence technologies for data processing to predict yields, optimize irrigation in case of droughts, and, as a result, prevent risks of crop and income losses, increase productivity and improve food security. Artificial intelligence robotics, such as robot harvesters, drones, and unmanned tractors, can significantly reduce resource use through precision farming, thus reducing farmers' costs. These types of innovations require significant investment and energy resources, which are not always available to small farmers. In addition, agricultural technologies are not always applicable to real-time farming.

The growth of resource efficiency in the EU agricultural sector is evidenced by the index of real incomes in the sector between 2016 and 2024 (as a ratio of all incomes to annual labour units). In 2016, the index of real income in the EU agricultural sector was 99.61% (about 2015 prices), while in 2020 it increased to 123.46%, and in 2024, to 137.19% (Eurostat, 2025c). The highest growth in income per annual labour unit was recorded in Denmark, Luxembourg, Greece, Germany, Italy, Latvia, Poland, Sweden, Belgium, and Bulgaria (Eurostat, 2025c). However, it is not possible to establish a direct link between

the growth of input use efficiency in the EU agricultural sector and the growth of organic farming and the contribution of agricultural practices to organic production. This is due to the available data on these indicators, which are published at the EU level for different periods.

The labour productivity factor in the EU agricultural sector between 2015 and 2024 showed that the volume of agricultural production relative to the annual number of labourers in the sector, especially at the beginning of 2020, is due to two factors (Table 2). Firstly, the level of employment in the sector decreased by 19% between 2015–2024, especially in Bulgaria, Greece, Hungary, Poland, and Denmark. This trend may indicate the mechanization of the sector (Eurostat, 2025d). Secondly, the volume of real economic growth in the EU agricultural sector in that period remained virtually unchanged. The market value of production in 2015 prices increased by only 0.34%, amounting to 390.9 billion euros in 2015 and 392.2 billion euros in 2024 (Eurostat, 2025e).

Table 2: Dynamics of Labour Productivity in the Agricultural Sector of the EU-27 in 2015–2024

Figure	2015	2016	2020	2021	2022	2023	2024	Deviation 2024- 2015, +/-	Growth rate, 2014/ 2015, %
Output of the agricultural 'industry' (Production value at basic price), billion euros	390.9	394.1	406.3	410.7	400.3	390.6	392.2	1.3	0.34%
Agricultural labour input statistics: absolute figures (1000 annual work units)	9307.9	9507.0	8026.6	8014.7	7736.7	7600.0	7530.0	-1777.9	-19.10%
Labour productivity, billion euros/AWU	42,0	41,5	50,6	51,2	51,7	51,4	52,1	10,1	24,03%

Source: Eurostat (2025d, 2025e)

The European Commission estimates that between 2005 and 2024, farms have become more productive and sustainable due to increased farm size, specialization, and growing economies of scale. Economies of scale allowed farmers to reduce average unit costs while increasing output. This has supported an increase in investment for this sector. In the EU, there has been an increase in specialized production of different crops, and the number of mixed farms has decreased. These changes were driven by macroeconomic factors, product prices, and farmers' incomes as they adapted to new market conditions. The study of the productivity of organic farming land in the EU for the 2016 to 2023

period, estimated as the ratio of arable organic land to organic production, indicates an increase due to an increase in the annual production of various types of grain crops. In 2016, the productivity was 3%, in 2020 and 2023 it increased to 5%. At the same time, the productivity of organic farming land grew at a slower rate than the productivity of the entire EU agricultural sector in 2017–2022.

The highest level of organic land productivity is in Estonia, Italy, Lithuania, Austria, Slovakia, Finland, Sweden (above 7%), the average level of productivity is in Greece, Latvia (5-7%), and the lowest level is in Bulgaria, the Czech Republic, Spain, France, Croatia, Luxembourg, Hungary, the Netherlands, Poland, Romania, and Slovenia (less than 5%) (Table 3).

Table 3: Land productivity of organic farming in the EU countries in 2016, 2020, 2023 (hectares/ton)

Country	Land productivity of organic farming		
	2016	2020	2023
European Union – countries	3%	5%	5%
Belgium	2%	4%	5%
Bulgaria	0%	1%	1%
Czechia	2%	3%	3%
Estonia	5%	10%	10%
Ireland	0%	0%	0%
Greece	4%	5%	6%
Spain	1%	2%	1%
France	2%	3%	4%
Croatia	4%	5%	4%
Italy	6%	8%	8%
Cyprus	0%	0%	0%
Latvia	3%	6%	6%
Lithuania	4%	10%	7%
Luxembourg	1%	3%	3%
Hungary	1%	2%	2%
Malta	0%	0%	0%
Netherlands	1%	1%	1%
Austria	6%	12%	13%
Poland	1%	2%	2%
Romania	2%	2%	3%
Slovenia	1%	0%	0%
Slovakia	3%	14%	14%
Finland	3%	9%	10%
Sweden	9%	18%	18%

Source: Eurostat (2025a, 2025f)

Despite significant changes in improving the productivity and efficiency of the use of inputs in the EU agricultural sector, according to the UN, by 2022, almost 9.2% of people (735 million people globally) were in a state of chronic hunger. In 2022, 2.4 billion people were in severe or moderate food crisis, lacking affordable food (United Nations,

2025). Therefore, the problem of eliminating hunger remains relevant. This is also confirmed by McConnell, Osorio and Hofmann (2023): due to inefficient use of resources and inequality of access, achieving zero hunger remains a global challenge. Increasing resource efficiency can partially contribute to reducing hunger. As this study shows, this is possible by increasing the income of the agricultural sector by reducing the use of labour resources and at the same time introducing artificial intelligence technologies to prevent crop losses and robotics to reduce labour requirements.

Despite the lack of direct links between agricultural practices and the goal of ending hunger, the sustainability of the agricultural sector continues to have an indirect impact on solving problems.

According to the 2025 Sustainable Development Goals assessment, there are ongoing significant challenges in all EU countries with the conservation of biodiversity and the environment, including sustainable food and land systems (SDG 2, SDG 12-15) (Lafortune and Grayson, 2025). Compared to the significant progress in overcoming poverty (SDG 1) or reducing inequality (SDG 10), achieving the goal of zero hunger remains a significant challenge for all EU countries (Table 4). However, environmental and biodiversity loss is partly due to the slow reduction of ammonia emissions in agriculture and the EU's granting permits to companies for the import of products with pesticides. There is a gap in agricultural yields between EU countries, which is also slowly decreasing (Sustainable Development Report 2025).

Table 4: Status of achievement of SDG 1, SDG 2 and SDG 10 in EU countries in 2025

Country	SDG Index Score (0-100)	SDG Index Rank	SDG1: No Poverty		SDG2: No Hunger		SDG10: Reduced Inequalities	
Finland	81.1	1	green	↗	Red	→	green	↗
Denmark	79.7	2	Green	↗	orange	→	green	→
Sweden	79.4	3	Yellow	→	orange	→	yellow	↓
Austria	77.3	4	Green	→	orange	↓	green	→
Norway	76.2	5	Green	→	orange	→	green	↑
Germany	75.0	6	Yellow	→	orange	→	yellow	→
France	73.9	7	Yellow	→	orange	→	yellow	→
Slovenia	73.8	8	Green	↑	Red	→	green	↑
Czechia	73.7	9	Green	↗	Red	→	green	↑
Iceland	73.4	10	Green	↑	Red	→	green	
Poland	73.3	11	Yellow	↑	orange	→	green	↑

UK	72.7	12	Yellow	↑	Red	→	orange	→
Croatia	72.4	14	Yellow	↗	orange	↗	yellow	↑
Italy	72.3	15	Yellow	↗	orange	↗	orange	→
Belgium	72.2	16	Yellow	↗	orange	→	green	↑
Netherlands	71.9	17	Green	↗	Red	→	yellow	↗
Estonia	71.7	18	Orange	↗	Red	→	yellow	↗
Ireland	71.5	19	Yellow	↑	orange	→	yellow	↗
Spain	71.2	20	Orange	→	Red	→	yellow	↑
Latvia	70.6	21	Orange	↗	red	→	orange	→
Portugal	70.6	22	Yellow	↑	orange	→	yellow	↗
Slovakia	70.6	23	Yellow	↗	orange	→	green	↑
Malta	69.3	24	Yellow	→	red	↓	yellow	↓
Hungary	68.8	25	Yellow	↑	red	↓	Green	↗
Lithuania	67.8	26	Orange	↗	red	→	Orange	→
Luxembourg	67.6	27	Yellow	↗	orange	→	Yellow	→
Greece	66.5	28	Orange	↗	orange	↗	Yellow	↑

Yellow Challenges remain

Orange Significant challenges

Red Major challenges

Source: Lafortune and Grayson (2025)

Other studies support the hypothesis that sustainable agricultural practices contribute to the achievement of the goal of zero hunger (Nikonenko *et al.*, 2022). Thus, Mishra and Mishra (2024) point out the important link between zero hunger and sustainable agriculture, including smart agriculture. Key strategies to eliminate hunger include yield and crop management, supply chain optimization, digital financial inclusion, and food waste reduction.

As the results of this study show, overall, the productivity of the agricultural sector has increased, thus increasing its capacity to address hunger. This correlates with the findings of Chen, Shuai and Wu (2023) that food security is enhanced by strengthening agricultural resilience. However, to strengthen the resilience of the agricultural sector, it is important to ensure that there are sufficient resources to address the problem of

reducing hunger (Nakai, 2018), to introduce mandatory accountability in the implementation of agricultural practices (financing, implementation, results), and to introduce mandatory monitoring in the implementation of various management practices. It is important to promote the introduction of innovative methods of soil cultivation and agrotechnological innovations at the state level (Sumets *et al.*, 2022). To do this, governments should introduce financial incentives that would expand farmers' ability to purchase yield forecasting technologies or robotics. These incentives may become part of the national eco-schemes for the development of digital agriculture proposed under the EU CAP. Farmers will be able to receive direct reimbursements for the purchase of hardware and software for precision agriculture (plant protection technologies, fertilizer application, precision seeding technologies, seeding monitoring, soil analysis). These technologies contribute to more sustainable agricultural production, indirectly affecting the quantity and quality of crops, yields, and farmers' incomes. Reducing crop losses through robotics and thus increasing food production is an indirect factor in reducing hunger. Additional factors in achieving zero hunger are the development of agricultural supply chains and their availability for regions with a high degree of food shortage by providing EU farmers with access to direct access to foreign markets.

Discussion

Organic farming, as one of the ways to ensure sustainable management in the agricultural sector, is characterized by a downward trend in Greece, Italy, Romania, France, Ireland, and Germany during 2010-2020. However, an upward trend in organic farming was observed in Lithuania, Iceland, Hungary, Spain, and Bulgaria for the same period. As of 2022, the share of cultivated organic land was 10.5%. It can be deduced that, in general, sustainable farming can be considered as undergoing an upward trend. In addition, traditional methods of soil cultivation prevail in the EU. As of 2016, few countries show conservation farming practices being more widespread (Bulgaria, Germany, Cyprus, Portugal, the Czech Republic, France, Austria, Estonia), with a share of 25-55%. As of 2024, EU countries still face problems concerning efficient soil use practices, which reduce their productivity and do not contribute to the goal of sustainable agriculture as a prerequisite for overcoming hunger.

Agrotechnological innovations can also be considered as needing an upward trend in the activities of agricultural enterprises despite the high cost of their integration. Therefore, the role of agricultural practices in achieving the goal of zero hunger remains limited. In tandem, there is considerable potential in the introduction of agro-technological innovations in the agricultural sector to address issues of increasing land productivity, forecasting yields, optimizing irrigation in droughts to prevent the risk of crop losses for farmers, and reducing resource use through precision farming technologies by 2030.

Today, the growth of resource efficiency in the agricultural sector is ensured by agricultural automation technologies. This technology allowed the sector to reduce the number of required labor resources employed in the sector in 2016-2024. Automation also resulted in an increase in real revenues in 2016-2024. Thus, significant progress has been made in ensuring the growth of farmers' incomes as one of the key indicators of the Zero Hunger goal. Another indicator of achieving the Sustainable Development Goal

“zero hunger” is an increase in agricultural productivity. The results of the article demonstrate that productivity in the EU countries increased by 24% from 2015 to 2024 due to a reduction in employment as a result of production automation. However, in general, agricultural output in 2015-2024 was characterized by stability. Additional factors contributing to the sustainability of the sector are the increase in the size of farms, the specialization of their activities, and the growth of economies of scale. This implies a reduction in average production costs while increasing output.

It is worth noting that an important factor in improving the sustainability of the agricultural sector is the productivity of organic farmland in the EU in 2016-2023. This dynamic was due to an increase in the annual production of various types of grain crops. Therefore, organic farming, as one of the most widespread methods of sustainable farming, can be considered one of the additional factors of sustainable development in the EU. Between 2015 and 2024, there was a steady although, slow trend towards progress in achieving the Sustainable Development Goals, in particular the goal of zero hunger, even though, nearly 9.2% of the world's population was chronically hungry as of the end of 2022. Achieving the Zero Hunger goal is a significant challenge for all EU member states. The main reasons for this are inefficient use of resources and unequal access to resources. Increasing the level of use of agricultural practices worldwide can solve the problem of inefficiency. The problem of accessibility refers to unequal access to quality food in different countries with different income levels, weak infrastructure and seasonal price fluctuations. In addition, small farmers often lack secure land rights, access to insurance, credit, subsidies, and support to ensure more sustainable production. Small producers often lack the knowledge to market their products, making it difficult for them to enter foreign markets.

The development of sustainable agriculture plays a crucial role in overcoming hunger by increasing efficiency, ensuring environmentally friendly and economically viable food production in the long term (Hiywotu, 2025). At the same time, sustainable agriculture requires multidimensional strategies that cover not only innovations and new management methods, but also economically and environmentally sustainable management of food systems. Such strategies (Hiywotu, 2025) include: agroecology to increase biodiversity (diversified crop rotations, integrated pest management), conservation agriculture (minimal tillage to increase productivity), efficient irrigation systems for sustainable use of water resources, use of organic metals (biopesticides), agroforestry, and others.

However, this requires government intervention and incentives for farmers not only to adopt innovative tillage methods, but also to use agro-technological innovations. Financial incentives for farmers' innovative activities should be a key part of government policy. It is also necessary to introduce additional incentives for farmers to use the additional income generated as a tool for financing sustainable agricultural production. The combination of these factors can ensure that most of the challenges in achieving the goal of zero hunger are on their way to be overcome. The current EU agriculture governance for 2020-2027 aims to achieve the goals of fair incomes for farmers, improving their position in the supply chain, rural development, and promoting knowledge and innovation. The new Common Agricultural Policy aims to create a sustainable food system to achieve the objectives of the strategy and the biodiversity

strategy. To achieve these goals, the policy envisages the creation of conditions and national strategic plans to establish a direct link between direct support for farmers' incomes and environmentally friendly farming practices (European Parliament, 2025). National eco-schemes under the CAP provide for payments by EU member states to create mandatory conditions for the development of a sustainable agricultural market. For example, at least 3% of arable land on each farm must be designated for biodiversity to be eligible for environmental support. At least 25% of the EU budget is to be allocated to finance eco-schemes as a tool to promote sustainable agricultural practices and environmentally friendly farming methods (including organic farming) (European Parliament, 2025).

According to Sporchia et al. (2024), national governments should push for the adoption of more sustainable agricultural practices (such as organic farming), while strengthening assessment and data collection methods in the agricultural sector. However, making it “mandatory” for farmers to implement such measures may not be feasible, given that most of them have financial constraints, including access to finance. Although such policies “may prevent the spread of profit-oriented practices” (Sporchia et al., 2024) that neglect food security, profits are important for continued food production and investment in innovation. To date, there is no direct link between the impact of increased farm income and the adoption of sustainable agricultural practices. Although SDG 2 envisages ending hunger through increased farm incomes, it is unlikely that this indicator has contributed to an increase in the use of innovative farming methods. This is evidenced by the state of organic farming in the EU. Although there has been an increase in farmers' incomes, the war in Ukraine and rising prices for various types of inputs will have direct negative consequences for food prices. This will again lead to a reduction in their affordability.

Furthermore, farmers' adaptation to climate change increases efficiency and productivity in food production, thus indirectly contributing to sustainability. Increasing the level of adaptability of farming activities can contribute to sustainable development. The main climate change adaptation measures include soil and water management through improved irrigation and new tillage methods (Khanal et al., 2021). It should be added that climate change adaptation measures can have a positive impact on solving the problem of biodegradation (Atukunda et al., 2021).

A separate problem in identifying and measuring the complex interrelationships between agricultural practices and the achievement of sustainable development goals is the lack of accurate quantitative indicators to assess them. Increased efficiency, labor productivity of the agricultural sector, and land productivity of organic farming may result from the automation of production (Voronina *et al.*, 2024). Therefore, the development of indicators for such an assessment remains an urgent issue. This issue is also covered in Villarino, Buenaseda Tejada and Patterson. (2022). To address the gaps in agricultural data, the 50 x 2030 initiative was launched in 2019, which involves partner countries working together to obtain timely, high-quality data on the state of the agricultural sector to track their progress towards achieving zero hunger. One of the indicators of the SDGs and the 50x2030 Initiative is “SDG 2.4.1 Proportion of agricultural area under productive and sustainable agriculture”. However, FAO data show that none of the countries reports on this indicator.

The experience of the EU's transition to organic farming demonstrates the possibility of implementing its principles and approaches in other regions, including the South Sahara and South Asia, taking into account local peculiarities of land law, infrastructure and access to their markets for foreign agricultural producers. In low-income countries, subsidies or grants to promote sustainable inputs (biofertilizers) can reduce costs. Targeted reimbursements to farmers for smallholder robotics would accelerate the adoption of organic, precision farming.

Conclusions

In the EU member states, there is a significant differentiation in the dynamics of organic farming and in the structure of implementation of various farming methods, with a predominance of conventional tillage methods. Conservation tillage is quite common (Bulgaria, Czech Republic, Germany, Estonia, Spain, France, Austria, Portugal). Minimal mechanical intervention is less common (Estonia, France, Italy, the Netherlands, Austria, Portugal). The total volume of organic farming in the Member States decreased during 2010–2020. Therefore, it is not possible to accurately assess the impact of different farming methods on the achievement of the Sustainable Development Goal to end hunger. Notwithstanding, other important indicators of the sector indicate trends towards increased sustainability of both the EU agricultural sector in general and organic farming in particular. Therefore, the EU Agricultural Real Income Index having an upward trend between 2016 and 2024, indicates the potential of relevant activities to achieve the Sustainable Development Goals to eliminate hunger. Income is one of the key factors of sustainability that allows investing in new tillage methods, technologies and innovations. The increase in agricultural productivity due to mechanization and reduced employment indicates an increase in the level of sustainable agricultural practices. The increase in the productivity of organic land in the EU was due to an increase in the volume of organic production. Therefore, in general, there are positive changes in achieving the goal of overcoming hunger due to the growth of agricultural sector income, its overall productivity and the productivity of organic farming land. These factors will serve as the basis for the sustainability of the sector.

Further research should be directed to a detailed study of various factors supporting the sustainability of the agricultural sector in different countries, including income, expenses of enterprises as factors of investment in innovative management methods.

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Authors' Declarations and Essential Ethical Compliances

Authors' Contributions (in accordance with ICMJE criteria for authorship)

Contribution	Author 1	Author 2	Author 3	Author 4	Author 5
Conceived and designed the research or analysis	Yes	No	Yes	Yes	Yes
Collected the data	Yes	No	Yes	No	No
Contributed to data analysis & interpretation	Yes	Yes	No	Yes	No
Wrote the article/paper	Yes	Yes	Yes	No	Yes
Critical revision of the article/paper	No	Yes	No	Yes	No
Editing of the article/paper	No	Yes	Yes	No	Yes
Supervision	No	Yes	No	Yes	Yes
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